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Influence of education and neighborhood poverty on pressor responses to phenylephrine in African-Americans and Caucasian-Americans

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ABSTRACT

Although neighborhood disadvantage has been linked to the development of cardiovascular disease, the mechanism through which living in impoverished neighborhoods is associated with poor cardiovascular health is not well understood. Additionally, it is not clear whether individual socioeconomic status (SES) interacts with neighborhood factors to influence cardiovascular outcomes. Using multilevel modeling, we examined the interaction between neighborhood poverty and individual SES on pressor responses to an alpha agonist, phenylephrine (PE), in an adult sample of 105 African-Americans and 106 Caucasian-Americans. Neighborhood poverty was assessed using census block data gathered from the Census Bureau. Education and occupation were used to assess individual SES. Pressor responsiveness was calculated as the systolic and diastolic blood pressure (BP) response to a 100-μg PE bolus administered intravenously. There was a significant interaction between education and neighborhood poverty on pressor responses. Higher education was associated with smaller BP responses to PE; but only in individuals who lived in neighborhoods in which less than 5% of the residents lived below the poverty line. Occupation was unrelated to pressor responses to PE. These results suggest that neighborhood characteristics play an important role in cardiovascular functioning.

1. Introduction

Neighborhood disadvantage has been linked to the development of cardiovascular disease. There is a higher incidence of cardiovascular disease (CVD) in lower SES individuals compared to higher SES individuals (Singh and Siahpush, 2002). Additionally, neighborhood poverty is associated with more CVD risk factors, such as diabetes, tobacco smoking, and obesity (Chen and Paterson, 2006; Cubbin, Hadden, and Winkleby, 2001). Epidemiological studies using census data reveal higher rates of hypertension and stroke among individuals who live in low SES neighborhoods (Anand et al., 2007; Bravata et al., 2005; Loucks et al., 2007; McClellan, 2005; Nzerue et al., 2002). Additionally, recent evidence suggests that neighborhood disadvantage is associated with carotid artery atherosclerosis in untreated hypertensives (Petersen et al., 2006).

Living in disadvantaged communities may be associated with poor health due to poor neighborhood safety and lack of resources within the community to support healthy lifestyles. Compared to affluent neighborhoods, poor neighborhoods are more likely to have higher crime rates (Sundquist et al., 2006), lack of access to healthy foods (Echeverria et al., 2004; Krummel et al., 2001; Morland et al., 2006), limited recreation and environments that discourage physical activity (Echeverria et al., 2004), as well as lack of access to health care and health information (Blair et al., 2002). These characteristics may contribute to the higher rates of CVD among those who live in low SES neighborhoods.

It is clear that living in impoverished neighborhoods is associated with increased cardiovascular morbidity (Anand et al., 2007; Cozier et al., 2007). However, the mechanism through which this occurs is not well understood. Few studies have examined whether individuals who live in more impoverished neighborhoods have greater blood pressure responsiveness than those who live in wealthier neighborhoods, and among those studies conducted in this area the findings have been mixed, with some researchers finding more reactivity among those who live in low SES neighborhoods (Kapuku et al., 2002) and others not finding such as association (Suchday et al., 2005). Given that research suggests blood pressure reactivity predicts the future development of hypertension in normotensive individuals (Flaa et al., 2008; Williams, 2006), more research is needed to understand the relationship between neighborhood SES and vascular reactivity, as

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a potential mechanism leading to higher CVD among those living in impoverished neighborhoods.

One way of examining vascular reactivity is to measure blood pressure (BP) after infusing a standard dose of phenylephrine (PE), a drug that stimulates the same vasoconstricting α receptors that norepinephrine does. Similar to other laboratory tests of vascular reactivity, research consistently demonstrates that α agonists such as PE lead to a transient increase in BP that mimics the effects of short term stress (Dimsdale et al., 1987; Sherwood and Hinderliter, 1993; Stein et al., 2000). Although PE infusions lead to increases in BP, the magnitude of this effect is influenced by demographic factors, such as hypertension status, age, gender, and ethnicity (Dimsdale et al., 1987; Elliott et al., 1982; Sherwood and Hinderliter, 1993). In this study, we examine whether SES also influences BP responses to PE.

Evidence suggests that neighborhood poverty may interact with individual-level SES and ethnicity to influence health. For instance, the effect of neighborhood poverty on self-reported health status is worst among those with lower individual income (Kobetz et al., 2003). Additionally, there is a higher mortality rate among African-Americans living in impoverished neighborhoods than among Caucasian-Americans in impoverished neighborhoods (Subramanian et al., 2005). Exploring interactions between neighborhood poverty and individual-level factors on vascular reactivity is a critical next step in obtaining a complete picture of the process through which socioeconomic factors influence cardiovascular health. In particular, it is unclear whether individual socioeconomic factors, such as educational attainment or occupation, can buffer the effect of neighborhood poverty on vascular reactivity. This question is especially important for African-Americans, an ethnic group that is more likely to live in lower SES neighborhoods than their Caucasian-American counterparts with similar income and education levels (Iceland et al., 2005).

Skills and social benefits associated with increasing occupation and education levels, such as greater access to health information, a greater sense of control, and socialization to adopt health-promoting behaviors (Yen and Moss, 1999) may have positive cardiovascular effects. Thus, it is possible that African-Americans in higher educational brackets may adapt a healthier lifestyle, through increased physical activity and engaging in healthier eating habits. This may serve as a protective factor against the negative effects of living in socioeconomically disadvantaged neighborhoods on cardiovascular functioning.

To date, no published study has examined the interaction between neighborhood SES and individual-level factors on vascular reactivity in adult participants. However, a study conducted with African-American adolescents revealed that although African-American youth who lived in poorer neighborhoods had higher BP reactivity to a video game challenge, this effect was buffered by individual-level SES, such that those whose parents had a higher education or income had lower BP reactivity (Wilson et al., 2000). This suggests that individual-level SES may buffer the effects of neighborhood poverty on vascular reactivity. The current study extends this work by examining whether neighborhood poverty interacts with individual-level factors to predict pressor responses to PE in an adult sample.

Individual-level factors examined in this study included education, occupation, and ethnicity (African-American, Caucasian-American). We predicted that individual socioeconomic factors would interact with neighborhood poverty to predict pressor responses to PE. Specifically, we expected that pressor responses to PE would be greatest for participants who had low individual SES and lived in neighborhoods with higher poverty levels; whereas, high individual SES would buffer the effects of neighborhood poverty on pressor responses. We also examined the three-way interaction between ethnicity, neighborhood poverty, and individual SES. We expected that the protective effect of high individual SES on those who live in neighborhoods with more poverty would be strongest for African-Americans, given that they are more likely to live in lower SES neighborhoods.

2. Methods

2.1. Participants

Participants for the current study included 211 employed individuals who participated in two protocols of research on stress, ethnicity, and BP (1995–1999 and 2000–2004; see Table 2 for differences in sample characteristics between the two protocols). There were 105 African-Americans and 106 Caucasian-Americans. The sample consisted of 117 males and 94 females. Participants were recruited from the San Diego community via advertisement and referrals. Participants were between the ages of 25 and 52 (mean = 37.6, S.E.M. = 0.50), with an ideal body weight between 90 and 130% (MetropolitanLifeFoundation, 1983) and resting BP < 180/110 mm Hg at screening. Screening BP was defined as the average of 3 seated BP's. Women were excluded if postmenopausal, diagnosed with pre-menstrual syndrome, taking oral contraceptives, or pregnant. Individuals with major medical conditions other than hypertension or with a psychiatric disorder were excluded from the study. Screening BP was taken using Dinamap model 1846-SZ with appropriate size cuffs. Participants whose systolic BP was above 140 mmHg and/or whose diastolic BP was above 90 mmHg were considered hypertensive. Concerning BP status, 50 of the participants were hypertensive (32 African-Americans and 18 Caucasian-Americans) and 160 were normotensive. No patient was taking antihypertensive medications.

2.2. Socioeconomic status

2.2.1. Individual-level SES

Individual SES was measured using education and the occupation factor of the Hollingshead two factor index of social position (Hollingshead, 1958). Education was measured on a 5 point scale, with responses ranging from 1 (partial high school) to 5 (graduate degree). Scores on the occupation factor ranged from 1 to 7, with higher scores representing higher social status occupations. A ranking of 7 was given to someone whose reported occupation is classified as a higher executive or major professional, such as a bank president or a judge. In contrast, a ranking of 1 was given to someone whose reported occupation is classified as an unskilled employee such as a janitor or factory worker. Validation studies support the utility of the Hollingshead scale as a reliable and valid measure of social status (Hollingshead, 1958).

2.2.2. Neighborhood demographic characteristics

Census block data were gathered from the Census Bureau American Fact Finder Census 2000 datasets (2000, 2001; Census, 2001) and used to characterize neighborhood SES. Census block, which is a subdivision of a census tract, is the smallest geographic unit created by the Census Bureau and enables researchers to determine neighborhood SES with greater precision than using zip code data alone. Percentage of individuals living below the poverty line in the census block was used to determine neighborhood SES. Poverty statistics were calculated by the Census Bureau using a weighted average threshold, which is based on family income and the number of individuals in the household. In a single person household, income levels below $8501 were considered below the poverty line. Using information collected from each household, the Census Bureau calculates the percentage of households in each census block living below the poverty line.

2.3. Pressor sensitivity

Data from baroreflex testing were used to assess pressor sensitivity. During baroreflex testing, a Finapres BP cuff (Ohmeda, 2300) was used to measure BP signals that were relayed to an A/D converter (Data Translation, DT2801), sampling at 1 kHz per channel (Global laboratory software, Data Translation) and stored in an IBM PC compatible computer in 3-min epochs. The Finapres BP cuff was placed on the third or fourth digit of the hand opposite the venous injection site. Hand position and cuff location were adjusted so that the Finapres readings were within 5 mmHg of casual BP determinations.

The participants were tested for their response to PE in the UCSD General Clinical Research Center in the afternoon. After resting supine for at least 20 min, baseline data were collected over the last 3 min of the 20 min resting period. Immediately following baseline, a 100 μg PE bolus was administered intravenously. Pressor sensitivity was assessed by recording the changes in BP in response to PE and was calculated as peak level BP in response to PE dosage minus baseline BP.

2.4. Statistical analysis

2.4.1. Group comparisons

Independent samples *t*-tests were conducted to examine differences in sample characteristics between African-Americans and Caucasian-Americans (see Table 1) as well as between the 1996–1999 and 2000–2004 protocols (see Table 2).